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PATENT  
Attorney Docket No.: KOW - 1859



**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:

Examiner: Dote Janis J

Yoshizawa, et al.

Serial No.: 10/800,569

Art Unit: 1756

Filed: March 15, 2004

Title: Image forming method and image forming apparatus

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**Declaration of prior invention in the United States or in a NAFTA or WTO member  
country to overcome cited patent or publication( 37 C.F.R. § 1.131)**

**Purpose of declaration**

1. This declaration is to establish completion of the invention of this application in the WTO member of Japan, at a date prior to February 28, 2003, that is the effective date of the prior art Asano et al. (US 2003/018046 A1) which prior arts are cited by examiner.

2. The person making this declaration is the inventors of US Application 10/800,569.

**Fact**

3. The inventors invented the invention claimed in the US application 10/800,569

*In re Yoshizawa, et al.*  
U.S. Appln. No.: 10/800,569

Page 1 of 3

in Japan. The invention has been filed to Japanese patent office. The Japanese patent application has ;

Japanese patent application number; P2002-371944

Japanese patent application filing date; December 24, 2002

Japanese patent application title; Image forming apparatus

Japanese patent application publication number ; P2004-205618A

4. The invention described in the Japanese patent application has also been filed to United State Patent and Trademark office on the date of March 15, 2004. The US patent application number is 10/800,569.

5. Therefore actual reduction to practice of the invention claimed in the US Application 10/800,569 is prior to at least Japanese patent application filing date of December 24, 2002.

6. Prior art Asano et al. was filed on February 28, 2003 to United State Patent and Trademark office and published on September 25, 2003.

7. Therefore, the reduction to practice date of the present invention is prior to US filing dates of Asano et al.

#### Evidence

To establish the date of completion of the invention of this application, the following attached documents are submitted as evidence.

- a. Japanese patent application publication P2004-205618A
- b. Certified translation thereof

#### Conclusion

8. The invention of this application was completed in the WTO member of Japan,

at a date prior to February 28, 2003, that is the effective date of the prior art Asano et al.

Declaration

9. I hereby declare that all statements made herein of my own knowledge are true and that all statements made upon information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Executed on this Dec. 27, 2005. By: Hideo Yoshizawa  
Hideo Yoshizawa

Executed on this Dec. 27, 2005. By: Akihiko Itami  
Akihiko Itami



(3)

特許文獻3に開示された「画像形成方法」は、感光体上に残留するトナーをクリーニングするブラシ及び弾性体ゴムブレードの特性を規定したものである。

【0007】

【特許文獻1】

特開平11-249333号公報（特許請求の範囲）

【0008】

【特許文獻2】

特開2001-13732号公報（特許請求の範囲）

【0009】

【特許文獻3】

特開平9-27417号公報（特許請求の範囲）

【0010】

【発明が解決しようとする課題】

本発明は、上記の従来技術の問題点を解決した画像形成方法及び画像形成装置を提供することを目的とする。即ち、本発明の目的は、トナーの転写性、クリーニング性を改善し、画像特性を改善した感光体を提供することであり、長期にわたり高品質で安定した複写画像が得られる画像形成装置を提供するものである。

【0011】

【課題を解決するための手段】

発明者らは、球形トナーをクリーニング装置を有する画像形成を行う場合、感光体への微粒子の堆加と、脂肪層エスデルワックスを組み合わせると、感光体の表面にごく薄層のワックス層が形成され、層形成性が向上し、クリーニング性能が向上し、球形トナーで問題となっているクリーニング不良に対し、良好な特性を奏揮できることを思いだし、発明を完成した。

【0012】

これは、ワックス層を感光体表面に均一に設置するためには、均一な感光体表面よりも微小な凹凸があるほうが、ワックスの延着が効果的に進むためである。特に、感光体表面の凸部の傾度が他の部分よりも低い無機微粒子の場合、その部分がワックスを延着する研磨剤として働くと考えられる。

【0013】

また、無機微粒子の粒径は細かき事が望ましく、大きな粒子が粒子密度が低に分散されている場合には、粒子周辺のみにはワックスが付着するのみで、均一なワックス層形成が十分に図れない。

【0014】

さらに、より均一性を増すためには、粒子の表面性、バインダの層厚により、影響を受ける。粒子の分散性、バインダの密着性は、電位特性にも影響を与え、粒子、界面の条件によっては、電荷移動におけるトラップサイトとして働き、残留電荷上昇、感度低下等の悪影響が発生する。従って、以下の構成をとることにし、本発明を完成した。

【0015】

即ち、前記の装置は、下記の構成により達成される。

(1) 導電性支持体上に少なくとも感光層を設けて成る感光体上に、帯電、感光光により潜像を形成し、現像手段によりトナー像を形成し、転写手段により前記トナー像を被記録媒体に転写した後、前記感光体上の残留トナーをクリーニング手段により除去する画像形成装置において、前記トナーが、平均円形度が0.94以上であり、且つ、炭素数16以上のカルボン酸又は炭素数16以上のアルコールがエステル結合してなるワックスを含有し、且つ、前記感光層が、数平均一次粒子径1nm以上、100nm未満の無機微粒子を含有する表面層を有することを特徴とする画像形成装置。

【0016】

(2) 前記無機微粒子が、シリカである事を特徴とする前記(1)に記載の画像形成装置。

(4)

【0017】

(3) 前記トナーが、脂肪族金属塩を含有することを特徴とする前記(1)又は(2)に記載の画像形成装置。

【0018】

(4) 前記感光層の表面積が $R_a$ が0.02 $\mu\text{m}$ 以上、0.1 $\mu\text{m}$ 未満であることを特徴とする、前記(1)～(3)の何れか1項に記載の画像形成装置。

【0019】

(5) 前記クリーニング手段がブレードクリーニング方式であることを特徴とする前記(1)に記載の画像形成装置。

【0020】

(6) 前記クリーニング手段が、弾性体ゴムブレード又はブラシローラのいずれかを前記感光層に接触させてクリーニングすることを特徴とする前記(5)に記載の画像形成装置。

【0021】

(7) 前記弾性体ゴムブレードの前記感光層への当接方向が、前記感光体の回転方向に対しカウンタ方向であることを特徴とする前記(6)に記載の画像形成装置。

【0022】

【発明の実施の形態】

本発明の画像形成方法及び画像形成装置の実施の形態の説明に先立って、本発明に係る感光体、クリーニング手段を構成した画像形成装置の一例である電子写真方式のカラー複写機の構成を説明する。

【0023】

【画像形成装置の構成】

図1は、画像形成装置の一例であるカラー複写機の全体構成図である。

【0024】

この画像形成装置は、タンデム型カラー画像形成装置と称せられるもので、複写相の画像形成部10Y、10M、10C、10Bkと、ベルト状の中間転写体7と給紙搬送手段及び定着装置24とから成る。

【0025】

イエロー色の画像を形成する画像形成部10Yは、感光体1Yの周囲に配置された帯電手段2Y、露光手段3Y、現像装置4Y、クリーニング手段5Y、転写手段6Yを有する。マゼンタ色の画像を形成する画像形成部10Mは、感光体1M、帯電手段2M、露光手段3M、現像装置4M、クリーニング手段5M、転写手段6Mを有する。シアンの色の画像を形成する画像形成部10Cは、感光体1C、帯電手段2C、露光手段3C、現像装置4C、クリーニング手段5C、転写手段6Cを有する。黒色画像を形成する画像形成部10Bkは、感光体1Bk、帯電手段2Bk、露光手段3Bk、現像装置4Bk、クリーニング手段5Bk、転写手段6Bkを有する。

【0026】

中間転写体7は、複数のローラにより巻回され、回動可能に支持されている。画像形成部10Y、10M、10C、10Bkより形成された各色の画像は、回動する中間転写体7上に転写手段6Y、6M、6C、6Kにより逐次転写されて（一次転写）、合成されたカラー画像が形成される。給紙セット20内に設置された用紙Pは、給紙手段21により給紙され、給紙ローラ22A、22B、22C、レジストローラ23等を経て、転写手段6Aに搬送され、用紙P上にカラー画像が転写される（二次転写）。カラー画像が転写された用紙Pは、定着装置24により定着処理され、排紙ローラ25に排紙されて紙外の排紙トレイ26上に搬送される。

【0027】

一方、転写手段6Aにより用紙Pにカラー画像を転写した後、用紙Pを曲率分離した中間転写体7は、クリーニング手段8により残留トナーが除去される。

【0028】

(5)

図2は画像形成部10の断面図である。画像形成部10Y、10M、10C、10Rは同形状をなすから、以下、画像形成部10と称す。また、画像形成部10の各構成手段を、感光体1、帯電手段2、露光手段3、現像装置4、クリーニング手段5、転写手段6と称す。

[0029]

クリーニング手段5は、回転する感光体1上に形成されたトナー像を用紙Pに転写後に、感光体1上に残留するトナーをブラシローラ51及び弾性体ゴムプレート52によってクリーニングする。

[0030]

弾性体ゴムプレート52が感光体1の感光層へ当接する方向は、感光体1の回転方向に対しカウンタ方向である。

[0031]

[感光体]

本発明の画像形成方法及び画像形成装置に用いられる感光体は、帯電性支持体上に電荷発生物質（CGM）及び電荷輸送物質（CTM）を含有する機能分離型有機感光体である。

[0032]

[図構成]

図3は、上記本発明の感光体の層構成を説明する図であり、通常は図3(a)～(f)のような構成となる。図3(a)に示す層構成は、導電性支持体11上に電荷発生層CGLを形成し、これに電荷輸送層CTLを積層して感光層12Aを形成したものである。図3(b)は電荷発生層CGLと電荷輸送層CTLとを逆に配置した感光層12Bを形成したものである。図3(c)は図3(a)の層構成の感光層12Aと導電性支持体11との間に中間層13を設けた感光層12Cを示す。図3(d)は図3(b)の層構成の感光層12Bと導電性支持体11との間に中間層13を設けた感光層12Dを示す。図3(e)の層構成は電荷発生物質CGMと電荷輸送物質CTMを含有する感光層12Eを形成したものである。図3(f)は図3(e)の感光層12Eと導電性支持体11との間に中間層13を設けた感光層12Fを示す。

[0033]

図3(a)～(f)の構成において、最表層にはさらに保護層を設けることができる。この保護層には電荷輸送物質CTMを含有することが出来、いわゆる2層CTL型構成としてもよい。

[0034]

ここで、導電性支持体11上に図3(a)～(d)のように層構成の感光層12A又は12Bを設けて感光体1を形成する場合は、電荷発生層CGL12は、導電性支持体11もしくは電荷輸送層CTL上に直接あるいは必要に応じて保護層もしくはプロテクト層等の中間層を設けた上に、次の方法によって形成することができる。以下、感光層12A～12Fを感光層12と総称する。

[0035]

[感光層]

本発明の技術がインントは、感光体1の感光層12の表面が、無機微粒子とバインダーという、表面性の異なる2種類の性質の異なる相を有することにより、トナーに含有するワックス成分をフィリング等の影響を受けにくいように層中に、感光層12の表面に強く引き延ばして押し広げることにある。通常、感光層12の塗布液に無機微粒子を添加した場合に、無機微粒子が感光体バインダーで覆われ微密な意味では初期の表面層は均一なバインダー層となるが、これらについても、数マイクロメートルの長さで上記バインダーの境界は判別されることから、実質的に効果を得ない。

[0036]

本発明の表面層に含有される無機粒子の最も均一次粒子径は、1nm以上、100nm未満である。無機粒子としては、シリカ、酸化亜鉛、酸化チタン、酸化銅、酸化鉛、酸化亜鉛、酸化インジウム、酸化ビスマス、鉛をドープしたインジウム、アンチモンやタンタルを

(6)

ドープした酸化銅、酸化ジルコニウム等の微粒子を好ましく用いることができる。これらの無機粒子の中でもコスト、粒径の調整、表面処理の容易性等から、シリカ、特に表面を疎水化した疎水性シリカが好ましい。

[0037]

効果的に薄層を形成するためには、無機微粒子は、感光層12中で細かく、均一に分散されて居ることが望ましく、1nm以上100nm以下の凝集のない一次粒子径である必要がある。これよりも大きければ、一部不均一なワックスの付着がおこり、逆に画像欠陥を誘引する。

[0038]

感光層12は表面平滑性がある方が望ましく、平滑でないと同様に画像欠陥を誘引する。また、用いられるワックスは延展性の観点から前記延展率が10以上の脂肪族エステルワックスである必要がある。

[0039]

本発明に用いられる有機感光体の構成について述べる。本発明の有機感光体に用いられる電荷発生物質としては、特に制限はないが、例えばフクロシアニン染料、アゾ染料、多環キノロン染料、ペリレン染料、インジゴイド染料等である。

[0040]

特に、有機感光体には、フルオレン系アゾ染料、イミダゾールペリレン染料、アントラントロン染料、オキシチタニル系アフロシアニン染料を用いると感度、耐久性及び画質の面で著しく改善された効果を示す。これらの電荷発生物質は単独あるいは2種以上を組み合わせて用いることができる。

[0041]

[現像剤]

本発明の現像剤は、目的に応じて非磁性トナー若しくは磁性トナーを主成分とする一成分系現像剤であってもよく、または非磁性トナー及び磁性キャリアを主成分とする二成分系現像剤であってもよい。しかしながら現像剤の流動性及び降着電圧に優れていて、良質の白黒画像及びカラー画像が得られる点で二成分系現像剤が好ましい。

[0042]

[トナー]

本発明の現像剤用トナーは、粉砕造粒法または混合造粒法の何れの造粒法を用いて作製されてもよい。混合造粒法による場合は、トナーの着色剤、磁性微粒子、荷電制御剤、陽型剤及び重合性樹脂モノマー等の原材料を溶媒中に溶解もしくは分散させた後、該原材料中の樹脂モノマーを重合させる方法によって製造させることができる。

[0043]

トナーの形状は、下記式で示される形状係数の平均値（平均円形度）が0.940以上1.0以下、好ましくは0.960以上0.99以下であることが好ましい。

[0044]

$$\text{形状係数} = (\text{円相当径から求めた円周長}) / (\text{粒子投影像の周面長})$$

これにおいて、粒子投影像の周面長は、2000個のトナー粒子像の電子顕微鏡写真を、「SCANNING IMAGE ANALYZER」（日本電子社製）を使用して画像解析を行うことにより測定した。また、円相当径とは、投影トナー粒子像と同一面積の円の径を示す。

[0045]

また、形状係数の分布がシャープであることが好ましく、円形度の標準偏差は0.10以下がよく、下記式で算出されるCV値は20%未満が好ましく、さらに10%未満が好ましい。

[0046]

$$\text{CV値} = [(\text{円形度の標準偏差}) / (\text{平均円形度})] \times 100$$

平均円形度が0.990以下とすることで転写性を向上させることができる。また、0.940以上の平均円形度とすることは、粒子形状を極端な異形にしない事を意味し、長期に

(7)

互る使用時のストレスによる粒子の凝結性を抑制することができる。

[0047]

さらに、形状係数の分布がシャープであることが好ましく、円形度の標準偏差は0.10以下とすることで形状が増ったトナーとすることができる。トナー間での定着性促進を少なくすることができるため、定着率の向上及びオフセット体の底減による定着装置の汚染防止効果がより大きい。

[0048]

トナーに使用するワックスとしては、ペンタエリスリトールステアリン酸テトラエステル、ペンタエリスリトールベヘン酸テトラエステル、ペンタエリスリトールペヘニン酸ジエステル、ペンタエリスリトールベヘニン酸トリエステル、ネオペンチルグリコールベヘニン酸ジエステル、ノナンジオールとセバシン酸とステアリアルアルコールの混合物、デカンジオールとアゼライン酸とステアリアルアルコールの混合物等が挙げられる。

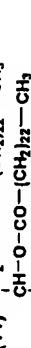
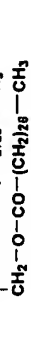
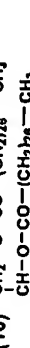
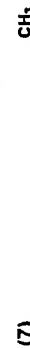
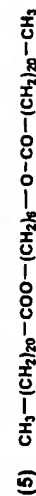
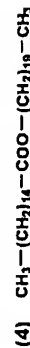
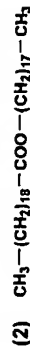
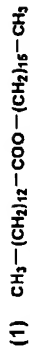
[0049]

代表的ワックスを以下に示す。

[0050]

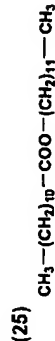
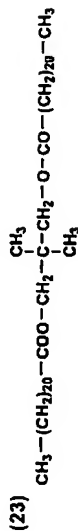
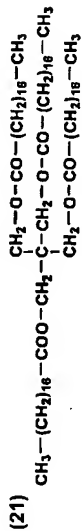
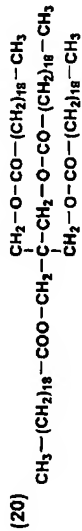
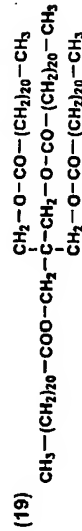
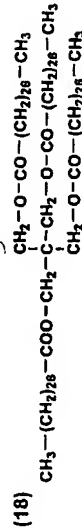
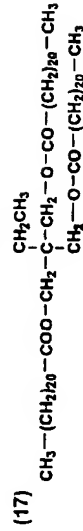
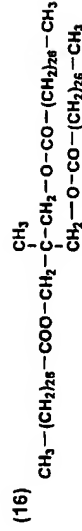
[化1]

(8)



[0051]

[化2]



[0052]

(防眩板全断面)

[illegible]

(10)

[illegible]

[0053]

[クリーニング手段]

〈ブラシローラ〉

本発明で用いられるブラスシロラ51のブラス材は、任意のものを用いることができるが、非水性で、かつ誘電率が低い樹脂形成性成分重合体を用いるのが好ましい。このような高分子重合体としては、例えばレーヨン、ナイロン、ポリカーボネート、ポリエステル、メタクリル樹脂、アクリル樹脂、ポリ塩化ビニル、ポリ塩化ビニリデン、ポリプロピレン、ポリスチレン、ポリビニルアルコール、スチレンブタジエン共重合体、塩化ビニル-アクリロニトリル共重合体、塩化ビニル-酢酸ビニル共重合体、塩化ビニル-酢酸ビニル-酢酸ビニル-無水マレイン共重合体、シリコン樹脂、シリコーン-アルキッド樹脂、フェノールホルムアルデヒド樹脂、スチレン-アルキッド樹脂、ポリビニルセタール（例えばポリビニルブチラール）等が挙げられる。これらのバインダ樹脂は単独であるいは2種以上の混合物として用いることができる。特に、好ましくはレーヨン、ナイロン、ポリエステル、アクリル、ポリプロピレンである。

[0054]

また、プラスチック 1 は、導電性でも絶縁性でもよく、構成素材にカーボン等の低抵抗物質を含有させ、任意の形状に調整したものが使用できる。

[0055]

ブラシの粗粒の太さは、6デニール以上、30デニール以下である。6デニールに満たないと、十分な線過力が無い。また、30デニールより大きいと、線能が剛直になるため感光体の表面を傷つけた。感光体の寿命を低下させる。

[0056]

ここでいう「デニール」とは、ブラシを構成する繊維の長さ9000mの質量をg（グラム）単位で測定した数値である。

[0057]

ブラシローラ51の繊維密度は、 $4.5 \times 10^2 \text{f/cm}^2$ 以上15.  $5 \times 10^2 \text{f/cm}^2$ 以下である。4.  $5 \times 10$

21 l/cm<sup>2</sup>に満たないと、酸過にムラができ付着物を均一に除去することができない。15・5×10<sup>2</sup> l/cm<sup>2</sup>より大きいと、ブラシ機械間に入り込んだ、トナー、異物が除去されず、バックキングが発生しブラシの特性が失われる。

[0058]

ブラシローラ 51 に用いられる支持体としては、主としてステンレス、アルミニウム等の金属、紙、プラスチック等が用いられるが、これらにより限定されるものではない。

[650]

また、必要に応じて、ブラシローラ51に付着したトナー、異物をブラシからはたき落とすための部材（フリッカー）をもうけて良い。

100601

本発明で用いられるブラシは、図2に示すように、円柱状の支持体51Aの表面に接層層を介してフエアーブラシを設置した構成であることが好ましい。

[1900]

〈弾性体ゴムブレード〉

本発明で用いられる弾性体ゴムブレード52は、図2に示すように、支持部材53上に自由端を持つように設けた溝状であることが好ましい。

[0062]

(11)

弾性体ゴムブレード52の感光体1の表面層への押圧力が5 g/cmより小さいと、十分なクリーニングが行われず、トナーのすり抜け等が発生する。また、30 g/cmより大きいと感光体の減耗が多くなり、感光体1の感度が低下し、かぶり等の画像不良が発生する。

【0063】

弾性体ゴムブレード52の自由端は、感光体1の回転方向と反対側（カウンタター）に圧接する。

【0064】

弾性体ゴムブレード52の、ゴム硬度はJISA 60°～70°、反発弾性は、30～70%、ヤング率は、30～60 kg/cm<sup>2</sup>、厚さは、1.5 mm～3.0 mm、自由長は、7～12 mmのものが好ましいが、特に限定するものではない。

【0065】

【実施例】

以下、本発明の実施例により具体的に説明するが、本発明の実施の形態がこれにより限定されるものではない。

【0066】

【感光体1の作製】

下記の様に感光体1を作製した。

【0067】

（導電性支持体）

直径80 mmφ、長さ346 mmの円筒形アルミニウム支持体の表面を切削加工し、表面粗さRz＝0.9（μm）の導電性支持体を用意した。

【0068】

（中間層）

下記中間層分散液と同じ混合溶媒にて2倍に希釈し、一夜静置後に濾過（フィルター：日本ポール社製リジメッシュ5 μmフィルター）し、中間層塗布液を作製した。

【0069】

ポリアミド樹脂（東レ社製 CM8000） 1部

酸化チタン（数平均一次粒径35 nmの酸化チタン粒子にシリカ・アルミナの一処理及びメチルハイドロジェンポリシロキサンとの二水処理を行ったもの） 3部

メタノール 10部

分散機としてサンドミルを用いて、バッチ式で10時間の分散を行った。

【0070】

上記中間層塗布液を用いて前記支持体上に、乾燥膜厚2 μmとなるよう塗布した。

【0071】

（電荷発生層（CGL））

Y型タニルフロロシロニン（Cu-Kα特性X線回折スペクトル測定で、ブラッグ角2θ（±0.2）の2θ7.2度に最大ピークを有するタニルフロロシロニン） 20部

ポリビニルブチラール樹脂（#6000-C：電気化学工業社製） 10部

酢酸1-プロピル 700部

4-メトキシ-4-メチル-2-ペンタノン 300部

を混合し、サンドミルを用いて10時間分散し、電荷発生層塗布液を調製した。この塗布液を前記中間層の上に塗布し、膜厚0.3 μmの電荷発生層を形成した。

【0072】

（電荷輸送層（CTL））

電荷輸送物質（4,4'-ジメチル-4'-(α-フェニルスチリル)トリフェニルアミン） 225部

ポリカーボネート（下記構造のポリカーボネート2：分子量3万、） 300部

酸化防止剤（Irganox1010：日本チバダイキ社製） 6部

(12)

1,3ジオキソソラン 2000部

メチル、フェニルポリシロキサン 1部

を混合し、溶解して電荷輸送層塗布液を調製した。この塗布液を前記電荷発生層の上に電荷塗布法で乾燥膜厚20 μmの電荷輸送層を形成した。

【0073】

（素面層）

電荷輸送物質（4,4'-ジメチル-4'-(α-フェニルスチリル)トリフェニルアミン） 225部

ポリカーボネート（下記構造のポリカーボネートA：分子量3万、吸水率0.25%） 300部

疎水性シリカ（表1）

ヒンダードアミン酸化防止剤 6部

1,3-ジオキソソラン 2000部

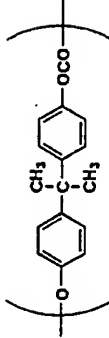
メチル、フェニルポリシロキサン 1部

を混合し、超音波を照射できる電荷分散装置にて電荷分散を行い、表面層塗布液を調製した。この塗布液を前記電荷輸送層の上に円形規則型塗布法により乾燥膜厚5 μmになるように塗布し、110℃で70分間の乾燥を行い、感光体1を作製した。得られた感光体の表面粗さRaが0.07 μmであった。同様にして、表1のように各種繊維微粒子を添加して、感光体を作製した。

【0074】

【化3】

ポリカーボネートA



【0075】

【表1】

(13)

No.	感光性シリカの数平均一次粒径	疎水性シリカ添加量	疎水性シリカ処理割合 (%)
OPC-1	60	10	76
OPC-4	80	10	72
OPC-6	12	45	71
OPC-3	20	10	0
OPC-5	120	20	72
OPC-2	5	10	75

[0076]

＜ラデックス調製例！＞

温度センサー、冷却管、窒素導入装置を付けた5000 mlのセバツブルフラスコに予めアニオン系活性剤、 $\beta$ -ナードシドステルベンゼンスルホニウム酸ナトリウム：SDS：7.08 gをイオン交換水（2760 g）に溶解させた溶液を加する。窒素流速で30 rpmの攪拌速度で攪拌しつつ、内温を80℃に昇温させた。一方で例示化合物（9）72.0 gをスチレン115.1 g、n-ブチルアクリレート42.0 g、メタクリル酸10.9 gからなるノーマーに加え、80℃に加圧し溶解させ、モノマー溶液を攪製した。

【2200】

こで循環回路を有する機械式分散機により上記の加熱溶液を混合分散させ、均一な分散

(P1)

粒子種を有する乳化粒子を作製した。ついで、重合開始剤（過硫酸カリウム）0.84gをイオン交換水20.0gに溶解させた溶液を加熱し80℃にて3時間加熱、攪拌することによって重合を開始した。引き続き更に重合開始剤7.73gをイオン交換水24.0mlに溶解させた溶液を添加し、15分後、80℃で攪拌し38.3.6g、n-ブチルアクリレート14.0.0g、メタクリル酸36.4g、オクテリレン13.7gの混合液を12.6分間攪拌し、ついで、重合開始剤をさらに添加し攪拌させた後40℃まで冷却しラテックス粒立を1度下ろした。再度攪拌後60分加熱攪拌させた後40℃まで冷却しラテックス粒立を1度下ろした。ラテックス1.1と、

【0078】

〈ラテックス調製例2〉

ラデックス調製例1において、チオグリセリンの代わりにチオグリコール酸エチルを15.0g使用し、例示化合物(19)の代わりに例示化合物(18)を120.0g使用した他は同様にラデックス粒を得た。これを「ラデックス2」とする。

[0079]

同様にして、例示化合物(18)の代わりに例示化合物(1)、(25)を用いた以外は、ラテックス調製例2と同様に、ラテックス3、4を得た。

【0800】

「トナーの調製例」

〈着色粒子1の製造〉

ユニバーシテリウム9.2gをイオン交換水150mlに溶解する。この液に、塩化ナトリウム9.2gを加え、20分後、クレアチンを用いて分散した。大塚電機工業株式会社の電気泳動速度計ELS-800を用いて、上記分散液の粘度を測定した結果、重量平均粘度が11.2mlであった。この分散液を「着色分散液1」とする。

[0081]

述の「ラテックスⅠ」1250gとイオン交換水2000ml及び「着色剤分散液Ⅰ」を、温度センサー、冷却管、蒸発導入装置、胴槽装置を付けた5リットルの四コロプラスチックに入れ攪拌する。30℃に調整した後、この溶液に、亜硫酸ナトリウムの水酸化ナトリウム水溶液を加え、pHを1.0. 0に調整して、攪拌した。55.2. 6gのイオン交換水72mlに溶解した水溶液を攪拌下、30℃にて10分間、酸化した。

【0082】

【表2】

着色粒子	ラテックス	温度℃ (±0.2℃)	加熱撹拌時間 (時間)
褐色粒子2	ラテックス2	87	6
褐色粒子3	ラテックス3	83	6
褐色粒子4	ラテックス4	90	6
褐色粒子5	ラテックス3	80	5
褐色粒子6	ラテックス3	90	6

**[0083]**

その後、3分間放置した後に、昇温を開始し、液温度90℃まで6分間昇温する（昇温速度=10℃/分）。その後、理想で粒径をキュルター・カウンター・A-11（堅研商標）にて測定し、体積平均粒径が6.5 μmになった時点で塩化ナトリウム115 gをイオン交換水700 mlに溶解した水溶液を添加し、粒子成長を停止させ、さらに懸濁して液温度90℃±2℃にて、6時間加熱攪拌し、塩析/懸濁させる。その後、6℃/minの条件で3



(17)

画像評価機として、コニカ（株）製デジタル複写機 S i t i o s 7 1 1 6 5 改造機を使用した。該画像評価機は、コロナ耐電、レーザー露光、反転現象、静電起写、爪分離、フレードクリーニング、クリーニング補助ブラシローラ採用のプロセスを有する。

【0090】

該画像評価機に、感光体1～6を搭載し、現像剤1～6を装填して評価した。クリーニング性及び画像評価は、商業用が7%の文字画像、人物顔写真、ベタ白画像、ベタ黒画像がそれぞれ1/4等分にあるオリジナル画像を、A4判中性紙に複写して行った。複写条件は最も厳しいと思われる高温（30℃）高温（80%RH）にて、連続10万枚コピーを実施し、以下の評価を行った。

【0091】

（他の評価）

連続10万枚コピー終了後の感光体表面の機械評価は、レーザー顕微鏡による機械深さを測定し、評価した。使用したレーザー顕微鏡は、レーザーテック1LM21W（登録商標）である。

【0092】

感光体上の対象の傷は、ドラム両端から各70mmの位置と、中央位置の円周面上で、対物20倍レンズの視野に入った傷の最大値を機械評価の対象とした。また、特に深い傷が数個で判った場合には、その傷を対象とした。

【0093】

- × Rmaxが2.5μmを超えるもの
- △ Rmaxが2.5μm以下、2.0μm未満
- Rmaxが2.0μm以下、1.5μm未満
- ◎ Rmaxが1.5μm以下の良好なもの

（クリーニング評価）

10万枚のコピー画像を全数検査した。

【0094】

- × トナーのすり抜けによる画像欠陥の発生が501枚以上で、実用上問題となるレベル
- △ トナーのすり抜けによる画像欠陥の発生が101枚～500枚で、実用可否の評価を必要とするレベル
- トナーのすり抜けによる画像欠陥の発生が31枚～100枚で、実用上問題ないレベル
- ◎ トナーのすり抜けによる画像欠陥の発生が30枚以下の良好なレベル

（フィルミングの評価）

感光体表面のフィルミングの評価は、連続5万枚コピー、連続10万枚コピーの各終了時に、レーザー顕微鏡（レーザーテック1LM21W（登録商標））で感光体表面を顕微鏡して評価した。

【0095】

- × 5万枚コピー、又は10万枚コピーで異物付着が著しいもの
- △ 5万枚コピーでは異物付着がないが、10万枚コピーで異物付着がある
- 10万枚コピーで異物付着が軽微なもの
- ◎ 10万枚コピーで異物付着が殆どないもの

他の評価、クリーニング評価、フィルミングの評価を表4に示す。

【0096】

【表4】

(18)

	傷の評価	クリーニング評価	フィルミング評価
実施例 1	◎	◎	◎
実施例 2	◎	◎	◎
実施例 3	◎	○	○
実施例 4	◎	○	△
実施例 5	○	△	△
実施例 6	◎	○	○
実施例 7	○	○	△
比較例 1	○	×	○
比較例 2	×	○	○
比較例 3	◎	△	×
比較例 4	◎	△	×

【0097】

【発明の効果】

本発明の画像形成装置により、円形度の高いトナーのクリーニング性、フィルミング性を改善し、長期にわたって安定した画像が得られる。

【図面の簡単な説明】

【図1】 画像形成装置の一例であるカラー複写機の全体構成図。

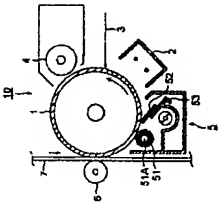
【図2】 画像形成部の断面図。

【図3】 本発明の感光体の層構成を説明する図。

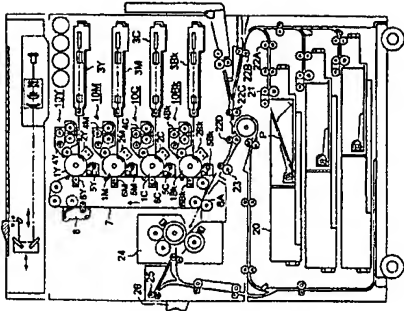
【符号の説明】

- 1, 1Y, 1M, 1C, 1Bk 像担持体（感光体）
- 5, 5Y, 5M, 5C, 5Bk クリーニング手段
- 10, 10Y, 10M, 10C, 10Bk 画像形成部
- 12, 12A, 12B, 12C, 12D, 12E, 12F 感光層
- 51 ブラシローラ
- 51A 支持体
- 52 弾性体ゴムブレード
- 53 支持部材

(19) 【図2】



【図1】



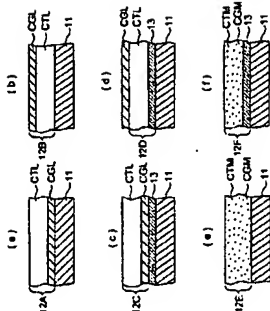
(20)

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(51)Int. Cl. 7

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G 0 3 G 21/00 3 1 8  
G 0 3 G 21/00 3 1 4

テーマコード (参考)

【図3】





Practitioner's Docket No.

KON-1859

Patent

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In re application of :Hideo Yoshizawa, Akihiko Itami

Application No 10/800,569

Group No.:

Filed: 3/15/2004

Examiner: Dote Janis J

For: IMAGE FORMING METHOD AND IMAGE FORMING APPARATUS

STATEMENT OF ACCURACY OF TRANSLATION  
(37 C.F.R. § 1.52(d), 1.55(a), 1.69)

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(54) Title of the invention

Image forming apparatus

(57) Abstract

[OBJECT]

To improve transfer ability, cleaning suitability and abrasion inhibition property of toner and to provide an image forming apparatus supplying a copy maintaining a high quality and stable image in a long period.

[MEANS TO SOLVE]

An image forming apparatus forming a latent image by charging and image exposure on a photoreceptor 1 having at least a photosensitive layer 12 formed on an electrically conductive substrate 11, forming a toner image with a development means, and removing remaining toner on the photoreceptor 1 with a cleaning means 5 after transferring the toner image to the recording medium with the transferring means, wherein the average circular degree of the toner is not less than 0.94 and the toner contains a wax comprising an ester of a carboxylic acid having carbon atoms of not less than 10 or an ester of an alcohol having carbon atoms of not less than 10, and the photosensitive layer 12 has a surface layer that contains inorganic particles having a number average of primary particle diameter in the range of 1 nm or more and less than 100 nm.

[SELECTED DRAWINGS] Fig. 2

[SCOPE OF PATENT CLAIMS].

[Claim 1] An image forming apparatus forming a latent image by charging and image exposure on a photoreceptor having at least a photosensitive layer formed on an electrically conductive substrate, forming a toner image with a development means, and removing remaining toner on the photoreceptor with a cleaning means after transferring the toner image to the recording medium with the transferring means, wherein an average circular degree of the toner is not less than 0.94 and the toner contains a wax comprising an ester of a carboxylic acid having carbon atoms of not less than 16 or an ester of an alcohol having carbon atoms of not less than 16, and the photosensitive layer has a surface layer that contains inorganic particles having a number average of primary particle diameter in the range of 1nm or more and less than 100 nm.

[Claim 2] The image forming apparatus of claim 1, wherein the inorganic particle is silica.

[Claim 3] The image forming apparatus of claims 1 or 2, wherein the toner contains a metal salt of fatty acid.

[Claim 4] The image forming apparatus of any one of claims 1 to 3, wherein surface roughness Ra of the layer is not less than 0.02  $\mu\text{m}$  and less than 0.1  $\mu\text{m}$ .

[Claim 5] The image forming apparatus of claim 1, wherein the cleaning method is a blade cleaning type method.

[Claim 6] The image forming apparatus of claim 5, wherein the cleaning means comprises an elastic rubber blade or a brush roller, and removing the toner remained on the photoreceptor is carried out by touching either of the elastic rubber blade or the brush roller to the photosensitive layer.

[Claim 7] The image forming apparatus of claim 6, wherein the cleaning blade is disposed so as to contact to the photosensitive layer in the counter direction to the rotating direction of the photoreceptor.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[TECHNICAL FIELD PERTAINING TO THE INVENTION]

This invention relates to an image forming apparatus having a photoreceptor and a toner to be used in an electrophotographic copier, printer and facsimile apparatus and a complex machine having such the functions.

[0002]

[PRIOR ART]

Recently, a spherical toner is investigated from the viewpoint of colorization of the image and further improvement of the image quality. However, the spherical toner is difficultly removed by cleaning, and a problem occurs such as passing the toner under the blade when blade cleaning is applied. Some measures have been proposed for solving such the problem.

[0003]

There is a problem, however, on the durability since a degraded image is caused by lowering of the developer recovering ability when the image formation is repeatedly performed. On the other hand, various investigations such as the addition of fine particles to the photoreceptor layer and the increasing of the

molecular weight of the binder resin have been performed corresponding to the requirements for improvement of the durability against the damage and the frictional wear.

[0004]

In "Image Forming Method and Image Forming Apparatus" disclosed in Patent Document 1, the charge transfer material of the photoreceptor and the developer containing inorganic fine particles are specified.

[0005]

"Toner, Production Method of Toner and Image Forming Apparatus" disclosed in Patent Document 2 relates to the shape coefficient and the average circular degree of the toner having the toner particle which contains a binder resin, a colorant, wax and a specified organic metal compound.

[0006]

In "Image Forming Method" disclosed in Patent Document 3, the physical properties of the cleaning brush and the elastic rubber blade are specified, by which the toner remaining on the photoreceptor is removed.

[0007]

[Patent Document 1]

Japanese Patent O.P.I. Publication, No. 11-249333 (Claims)

[0008]

[Patent Document 2]

Japanese Patent O.P.I. Publication No. 2001-13732 (Claims)

[0009]

[Patent Document 3]

Japanese Patent O.P.I. Publication No. 9-274427 (Claims)

[0010]

#### [PROBLEMS TO BE SOLVED BY THE PRESENT INVENTION]

An object of the invention is to provide an image forming method and image forming apparatus in which the foregoing problems of the usual technology are solved. That is, an object of the present invention is to provide a toner improved in the transfer ability and the cleaning suitability and a photoreceptor improved

in the resistivity against frictional wear and to provide an image forming apparatus, by which a copy image having a high image quality can be stably obtained for a long period.

[0011]

[MEANS TO SOLVE THE PROBLEMS]

It has been found by the inventors to complete the invention, particularly when an image is formed by a spherical toner in a apparatus having a cleaning device, that the releasing ability and cleaning suitability of the toner are raised and good properties can be displayed against cleaning defects which are problems of spherical toner by the combination of addition of fine particles in the photoreceptor and a fatty acid ester wax since a very thin layer of the wax is formed on the surface of the photoreceptor.

[0012]

It is considered that such the effects are obtained because the wax is more effectively spread when the photoreceptor surface has fine irregularities compared to that the surface is uniform. Particularly, the projections at the photoreceptor surface acts as abrasive for spreading the wax when the projection is an inorganic particle harder than the other portion.

[0013]

The particle diameter of the inorganic particles is preferably small since the wax is adhered only around the particle so that uniform wax layer cannot be sufficiently formed when the coarse particles are sparsely scattered.

[0014]

Further, the surface property of the particle and the kind of the binder are also influential for raising the uniformity. The dispersibility and the contact ability with the binder of the particle have influence on the potential property, and the particle acts as a trap site in the transition of charge according to the condition of the particle and the interface, consequently an influence such as rising in the remaining potential and

lowering in the sensitivity occurs. The present invention has been attained by employing the following configuration.

[0015]

That is, the above object is attained with the following configuration,

(1) An image forming apparatus forming a latent image by charging and image exposure on a photoreceptor having at least a photosensitive layer formed on an electrically conductive substrate, forming a toner image with a development means, and removing remaining toner on the photoreceptor with a cleaning means after transferring the toner image to the recording medium with the transferring means, wherein the average circular degree of the toner is not less than 0.94 and the toner contains a wax comprising an ester of a carboxylic acid having carbon atoms of not less than 16 or an ester of an alcohol having carbon atoms of not less than 16, and the photosensitive layer has a surface layer that contains inorganic particles having a number average of primary particle diameter in the range of 1 nm or more and less than 100 nm.

[0016]

(2) The image forming apparatus described in above (1), wherein the inorganic particle is silica.

[0017]

(3) The image forming apparatus described in above (1) or (2), wherein the toner contains a metal salt of fatty acid.

[0018]

(4) The image forming apparatus described in any one of above (1) to (3), wherein surface roughness Ra of the layer is not less than 0.02  $\mu\text{m}$  and less than 0.1  $\mu\text{m}$ .

[0019]

(5) The image forming apparatus described in above (1), wherein the cleaning method is a blade cleaning type.

[0020]

(6) The image forming apparatus described in above (5), wherein the cleaning means comprises an elastic rubber blade or a

brush roller, and removing the toner remained on the photoreceptor is carried out by touching either of the elastic rubber blade or the brush roller to the photosensitive layer.

[0021]

(7) The image forming apparatus described in above (6), wherein the cleaning blade is disposed so as to contact to the photosensitive layer in the counter direction to the rotating direction of the photoreceptor.

[0022]

[PREFERRED EMBODIMENT OF THE INVENTION]

Previous to the description of embodiments of the image forming method and the image forming apparatus of the invention, the constitution of an electrophotographic color copying machine as an example of an image forming apparatus is described, in which a photoreceptor and a cleaning means relating to the invention are installed.

[0023]

[Constitution of image forming apparatus]

Fig. 1 is a whole constitution of a color copying machine as an example of image forming apparatus.

[0024]

The image forming apparatus is one called as a tandem type color image forming apparatus which is constituted by plural units of image forming means 10Y, 10M, 10C and 10Bk, a belt-shaped intermediate transfer member 7 and a fixing device 24.

[0025]

The image forming unit 10Y for forming a yellow image has a charging means 2Y arranged around a photoreceptor 1Y, an exposing means 3Y, a developing means 4Y, a cleaning means 5Y, and a transfer means 6Y. The image forming unit 10M for forming a magenta image has a photoreceptor 1M, a charging means 2M, an exposing means 3M, a developing means 4M, a cleaning means 5M, and a transfer means 6M. The image forming unit 10C for forming a cyan image has a photoreceptor 1C, a charging means 2C, an exposing means 3C, a developing means 4C, a cleaning means 5C, and

a transfer means 6C. The image forming unit 10Bk for forming a black image has a photoreceptor 1Bk, a charging means 2Bk, an exposing means 3Bk, a developing means 4Bk, a cleaning means 5Bk, and a transfer means 6Bk.

[0026]

The intermediate transferring member 7 is put round on plural rollers and supported so as to be able to round. Color images each formed by the image forming units 10Y, 10M, 10C and 10Bk are successively transferred (primarily transferred) onto the rounding intermediate transfer member 7 by the transfer means 6Y, 6M, 6C and 6K, respectively, to form a synthesized color image. Paper P stored in a paper supplying cassette 20 is supplied by a paper supplying means 21 and conveyed to a transfer means 6A through paper supplying rollers 22A, 22B, 22C and a register roller 23, and the color image is transferred (secondarily transferred) onto the paper P. The paper P on which the color image has been transferred is fixed by the fixing device 24 and held by a paper output roller 25 to be stood onto a paper output tray 26.

[0027]

Besides, the toner remained on the intermediate transfer member 7 is removed by the cleaning means 8 after the color image is transferred to the paper P by the transfer means 6A and the paper is separated from the intermediate transfer member 7 by curvature of the paper.

[0028]

Fig. 2 shows a cross section of the image forming unit 10. Hereinafter the image forming unit is referred as "image forming unit 10" since the shapes of the image forming units 10Y, 10M, 10C and 10Bk are the same. The means for constituting the image forming unit 10 are each referred as the photoreceptor 1, charging means 2, exposure means 3, developing device 4, cleaning means 5 and transfer means 6.

[0029]

The cleaning means 5 remove the toner remained on the photoreceptor 1 by a brush roller 51 and an elastic rubber blade 52 after that the toner image formed on the rotating photoreceptor 1 is transferred onto the paper P.

[0030]

The touching direction of the elastic rubber blade 52 to the photosensitive layer of the photoreceptor 1 is counter to the rotating direction of the photoreceptor 1.

[0031]

[Photoreceptor]

A function separated type organic photoreceptor including a charge generation material (CGM) and a charge transfer material (CTM) on a electric conductive substrate may be used in the image forming method and the image forming apparatus according to the invention.

[0032]

<Layer constitution>

Fig. 3 shows drawings describing examples of possible layer constitutions of the photoreceptor of the invention above ; the constitutions are usually those shown in Fig. 3(a) through 3(f). In the layer constitution shown in Fig. 3(a), a charge generation layer CGL is formed on an electric conductive substrate 11 and a charge transfer layer CTL is placed on the CGL to form a photosensitive layer 12A. In Fig. 3(b), a photosensitive layer 12B is formed by reversing the order of the charge generation layer CGL and the charge transfer layer CTL. Fig. 3(c) shows a photosensitive layer 12C in which an interlayer 13 is provided between the photosensitive layer 12A and the electroconductive substrate 11 of the layer structure shown in Fig. 3(a). Fig. 3(d) shows a photosensitive layer 12D in which an interlayer 13 is provided between the photosensitive layer 12B and the electroconductive substrate 11 of the layer structure shown in Fig. 3(b). Fig. 3(e) shows a photosensitive layer 12E in which a photosensitive layer 12E containing the charge generation material CGM and the charge transfer material CTM is formed. Fig. 3(f)

shows a photosensitive layer 12F in which an interlayer 13 is provided between the photosensitive layer 12E and the electroconductive substrate 11 of the layer structure shown in Fig. 3(e).

[0033]

A protective layer may be provided as the outermost layer of the constitutions shown in Fig. 3(a) through (f). The protective layer can contain the charge generation material CTM so as to make a two-layer CTL type constitution.

[0034]

In the case of that the multi-layered photosensitive layer 12A or 12B is provided on the electroconductive substrate 11 to form the photoreceptor 1 as shown in Figs. 3(a) through (d), the charge generation layer CGL 12 can be formed directly or through an adhesion layer or a blocking layer, according to necessity, onto the electroconductive substrate 11 or the charge transfer layer CTL by the following method. Hereinafter, the photosensitive layers 12A through 12F are wholly referred to as the photoreceptor 12.

[0035]

<Photosensitive layer>

As a technical point of the invention, the wax contained in the toner is spread as a thin layer on the surface of the photosensitive layer 12 so as to inhibit any bad influence such as filming, because the surface of the photosensitive layer 12 of photoreceptor 1 has two phases of the inorganic particle and binder each different from the other in the surface properties. When the inorganic particle is added into the coating liquid of the photosensitive layer, the inorganic particles are usually covered by the binder of the photoreceptor and the initial surface becomes a uniform binder layer in the strict sense of the word. However, the effects is not degraded substantially since the covering by binder is peeled off by several hundreds times of practical copying.

[0036]

The number average of primary particle diameter of the inorganic particles contained in the surface layer of the invention is preferably from 1 nm to less than 100 nm. As the inorganic particle, can be used a fine particle of silica, zinc oxide, titanium oxide, tin oxide, antimony oxide, indium oxide, bismuth oxide, tin-doped indium, antimony- or tantalum-doped tin oxide and zirconium oxide. Among them, silica, particularly hydrophobic silica hydrophobilized at the surface thereof, is preferable from the viewpoint of the cost, easiness of the diameter control and that of the surface treatment.

[0037]

It is preferable for effectively forming the thin layer that the inorganic fine particles are finely and uniformly dispersed in the photosensitive layer 12. The primary particle diameter of the inorganic fine particles is preferably from 1 nm to 100 nm without aggregation. If the particle is larger than this, partially non-uniform wax adhesion occurs, resulting in introduction of image defects.

[0038]

The photosensitive layer 12 preferably has a smooth surface as a whole. When the surface of the photosensitive layer is not smooth, image defects are easily caused. Further, the used wax need to be fatty acid ester wax having carbon atoms of not less than 10 in view of spreading characteristics.

[0039]

The constitution of organic photoreceptors employed in this invention will now be explained. As the charge generation material to be used in the organic photoreceptor of the invention, for example, a phthalocyanine pigment, a polycyclic quinine pigment, an azo pigment, a perylene pigment and an indigoide pigment are usable even though there is no specific limitation.

[0040]

Particularly, the use of a fluorenone type bis-azo pigment, an imidazolylperylene pigment, an anthoanthrone pigment or an oxytitanyl type phthalocyanine pigment shows considerable

improving effects in the sensitivity, durability or image quality for the organic photoreceptor. These charge generation materials may be used solely or in combination of two or more kinds thereof.

[0041]

[Developer]

The developer of this invention either may be a one-component developer principally composed of a non-magnetic toner or a magnetic toner, or a two-component developer principally composed of non-magnetic toner and a magnetic carrier according to the purpose. However, the two-component developer is preferred since such the developer is superior in the fluidity and triboelectric property and a high quality black and white image or color image can be obtained.

[0042]

<Toner>

The toner for development of this invention may be prepared by either a crushing particle forming method or a polymerization particle forming method. In the case of the polymerization method, the toner can be produced by dissolving or dispersing raw materials such as a colorant of the toner, a magnetic fine particle, a charge controlling agent, a mold-releasing agent and a polymerizable resin monomer in a solvent and polymerizing the resin monomer in the raw materials.

[0043]

Concerning the shape of the toner, the average value of the shape coefficient (average circular degree) according to the following equation is preferably from 0.940 to 1.0, and more preferably from 0.960 to 0.99.

[0044]

Shape coefficient = (Circumference length of the circle calculated from the circle equivalent diameter) / (Circumference length of projection image of the particle)

In the above, the circumference length of the projection image of the particle is measured on an electron microscopic photograph of the toner particles taken with a magnitude of 2000

times by using Scanning Image Analyzer, manufactured by Nihon Denshi Co., Ltd for image analysis. The circle equivalent diameter is the diameter of a circle having an area the same as that of the projected image of the toner particle.

[0045]

It is preferable that the distribution of the shape coefficient is sharp, the standard deviation of the circular degree is preferably not more than 0.10 and a CV value calculated by the following equation is preferably less than 20%, and more preferably less than 10%.

[0046]

CV value = [(Deviation of circular degree)/(Average circular degree)] x 100

The transferring ability can be improved by making the average circular degree so as to be not more than 0.990. The average circular degree of not less than 0.940 means that the shape of the particle is not extreme irregular, and the crush of the particle caused by the stress during the use for a long period can be inhibited.

[0047]

The sharp distribution of the shape coefficient is preferred, and the toner composed of the particles each having similar shape can be prepared by making the standard deviation of the circular degree to not more than 0.10. Consequently, the difference of the fixing ability between the individual particles can be reduced and the prevention effect to the contamination of fixing device is enhanced by the improvement of the fixing ratio and the lowering of the off-set phenomenon.

[0048]

Examples of the wax to be used in the toner include pentaerythritol tetrastearate, pentaerythritol tetrabeheenate, pentaerythritol dibehenate, pentaerythritol tribehenate, neopentyl glycol dibehenate, a condensation product of nonanediol, sebacic acid and stearyl alcohol, and a condensation compound of decanediol, azelaic acid and stearyl alcohol.

[0049]

Typical waxes are listed below.

[0050]

[Chem 1]

- (1)  $\text{CH}_3-(\text{CH}_2)_{12}-\text{COO}-(\text{CH}_2)_{15}-\text{CH}_3$
- (2)  $\text{CH}_3-(\text{CH}_2)_{18}-\text{COO}-(\text{CH}_2)_{17}-\text{CH}_3$
- (3)  $\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-(\text{CH}_2)_{21}-\text{CH}_3$
- (4)  $\text{CH}_3-(\text{CH}_2)_{14}-\text{COO}-(\text{CH}_2)_{19}-\text{CH}_3$
- (5)  $\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-(\text{CH}_2)_6-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3$
- (6) 
$$\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-(\text{CH}_2)_2-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3$$
- (7) 
$$\text{CH}_3-(\text{CH}_2)_{22}-\text{COO}-(\text{CH}_2)_2-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3$$
- (8) 
$$\text{CH}_3-(\text{CH}_2)_{22}-\text{COO}-\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\underset{|}{\text{C}}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3$$
- (9) 
$$\text{CH}_3-(\text{CH}_2)_{26}-\text{COO}-\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\underset{|}{\text{C}}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3$$
- (10) 
$$\begin{array}{c} \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \\ | \\ \text{CH}-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \end{array}$$
- (11) 
$$\begin{array}{c} \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \\ | \\ \text{CH}-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \end{array}$$
- (12) 
$$\begin{array}{c} \text{CH}_2-\text{OH} \\ | \\ \text{CH}-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \end{array}$$
- (13) 
$$\begin{array}{c} \text{CH}_2-\text{OH} \\ | \\ \text{CH}-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \end{array}$$
- (14) 
$$\begin{array}{c} \text{CH}_2-\text{OH} \\ | \\ \text{CH}-\text{OH} \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3 \end{array}$$
- (15) 
$$\begin{array}{c} \text{CH}_2-\text{OH} \\ | \\ \text{CH}-\text{OH} \\ | \\ \text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{22}-\text{CH}_3 \end{array}$$

[0051]

[Chem 2]

- (16) 
$$\text{CH}_3-(\text{CH}_2)_{26}-\text{COO}-\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3$$
- (17) 
$$\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3$$
- (18) 
$$\text{CH}_3-(\text{CH}_2)_{26}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{26}-\text{CH}_3$$
- (19) 
$$\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3$$
- (20) 
$$\text{CH}_3-(\text{CH}_2)_{18}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{18}-\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{18}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{18}-\text{CH}_3$$
- (21) 
$$\text{CH}_3-(\text{CH}_2)_{16}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{16}-\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{16}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{16}-\text{CH}_3$$
- (22) 
$$\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-\text{CH}_2-\overset{\text{CH}_2-\text{O}-\text{CO}-\text{CH}_3}{\underset{\text{CH}_2-\text{O}-\text{CO}-\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-\text{CH}_3$$
- (23) 
$$\text{CH}_3-(\text{CH}_2)_{20}-\text{COO}-\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{O}-\text{CO}-(\text{CH}_2)_{20}-\text{CH}_3$$
- (24) 
$$\text{CH}_3-(\text{CH}_2)_{16}-\text{OCO}-(\text{CH}_2)_8-\text{COO}(\text{CH}_2)_3-\text{O}-\text{CO}-(\text{CH}_2)_8-\text{COO}(\text{CH}_2)_{16}\text{CH}_3$$
- (25) 
$$\text{CH}_3-(\text{CH}_2)_{10}-\text{COO}-(\text{CH}_2)_{11}-\text{CH}_3$$

[0052]

[Fatty acid metal salt]

Examples of the fatty acid metal salt used for the invention include aluminum stearate, calcium stearate, potassium stearate, magnesium stearate, barium stearate, lithium stearate, zinc stearate, copper stearate, lead stearate, nickel stearate, strontium stearate, cobalt stearate, cadmium stearate, zinc oleate, manganese oleate, iron oleate, cobalt oleate, copper oleate, magnesium oleate, lead oleate, zinc palmitate, cobalt palmitate, copper palmitate, magnesium palmitate, aluminum palmitate, calcium palmitate, zinc linolate, cobalt linolate, calcium linolate, zinc ricinolate, cadmium ricinolate and lead caproate. The using amount is from 0.01 to 10%, and preferably from 0.1 to 5%, by weight of the toner.

[0053]

[Cleaning means]

<Brush roller>

As the brush material of the brush roller 51 used in the invention, a fiber formable polymer having a hydrophobic property and high dielectric constant is preferably used even though optional ones may be used. Examples of such the polymer include rayon, nylon, polycarbonate, polyester, methacryl resin, acryl resin, poly(vinyl chloride), poly(vinylidene chloride), polypropylene, polystyrene, poly(vinyl acetate), styrene-butadiene copolymer, vinylidene chloride-acrylonitrile copolymer, vinyl chloride-vinyl acetate copolymer, vinyl chloride-vinyl acetate-maleic anhydride copolymer, silicone resin, silicone-alkyd resin, phenol-formaldehyde resin, styrene-alkyd resin and poly(vinyl acetal) such as poly(vinyl butyral). These binder resin may be used solely or in combination of two or more kinds thereof. Rayon, nylon, polyester, acryl resin and polypropylene are particularly preferred.

[0054]

The brush roller 51 may either be electroconductive or non-electroconductive. One adjusted to an optional resistivity by adding a low resistance material such as carbon to the constitution material.

[0055]

The thickness of the single fiber of the brush is from 6 denier to 30 denier. When the thickness is less than 6-denier, substance adhered to the surface cannot be removed since the frictional force is insufficient. When the thickness is more than 30 denier, the fiber damages the surface of the surface of the photoreceptor and shortens the life of the photoreceptor since the fiber is made too hard.

[0056]

The "denier" is a value represented by the weight in gram of 9,000 meter of the fiber constituting the brush. [0057]

The density of the fiber of the brush roller 51 is from  $4.5 \times 10^2 \text{f/cm}^2$  to  $15.5 \times 10^2 \text{f/cm}^2$ . When the density is less than  $4.5 \times 10^2 \text{f/cm}^2$ , friction becomes uneven and adhered substance cannot be uniformly removed and when the density is larger than  $15.5 \times 10^2 \text{f/cm}^2$ , the toner or a foreign substance having come between the brush fibers cannot be removed, resulting in packing and the properties of the brush are lost.

[0058]

As the substrate of the brush roller 51, a metal such as stainless steel and aluminum, paper and plastic are principally used. However, the material is not limited to the above.

[0059]

A means (flicker) may be provided according to necessity for striking down the toner and the foreign material adhered to the brush roller 51 from the brush.

[0060]

The brush used in the invention is preferably constituted by a cylindrical supporting means 51A and a far brush provided thereon through an adhering layer as shown in Fig. 2.

[0061]

<Elastic rubber blade>

It is preferable that the elastic rubber blade 52 used in the invention is provided on the supporting member 53 so as to have a free edge.

[0062]

If the pressing force of the elastic rubber blade 52 to the surface layer of the photoreceptor 1 is smaller than 5g/cm cleaning is not sufficiently carried out and the passing of the toner occurs. If it is larger than 30g/cm, the frictional wear of the photoreceptor increases and thus the lowering of the sensitivity of the photoreceptor 1 occurs so as to introduce occurrence of inferior image such as fogging.

[0063]

The free edge of the elastic rubber blade 52 is touched by pressure in the counter direction to the rotating direction of the photoreceptor 1.

[0064]

The elastic rubber blade 52 preferably has a rubber hardness of from 60° to 70° according to JISA, a repulsion elasticity of from 30 to 70%, a Young's modulus of from 30 to 60 kgf/cm<sup>2</sup>, a thickness of from 1.5 mm to 3.0 mm and a free length of from 7 to 12 mm, even though they are not specifically limited.

[0065]

[EXAMPLE]

The invention is concretely described below referring to examples, but the embodiment of the invention is not limited thereto.

[0066]

[Preparation of photoreceptor 1]

Photoreceptor 1 was prepared as follows.

[0067]

<Electroconductive substrate>

The surface of a cylindrical aluminum substrate having a diameter of 80 mm and a length of 346 mm was subjected to treatment so as to prepare an electroconductive substrate having a surface roughness Rz of 0.9 μm.

[0068]

<Interlayer>

The following dispersion for interlayer was diluted by 2 times by the same mixed solvent and filtered by Ridimesh 5  $\mu\text{m}$  filter, manufactured by Nihon Paul Co., Ltd., after standing for one night to prepare an interlayer coating liquid.

[0069]

Polyamide resin CM8000 (Toray Co., Ltd.) 1 part  
Titanium oxide (titanium oxide particles having a number average primary particle diameter of 35 nm, which was subjected to a primary treatment by silica-alumina and a secondary treatment by methylhydrogenpolysiloxane)

3 parts

Methanol 10 parts

The mixture was dispersed for 10 hours by a sand mill as a dispersing machine in a batch method.

[0070]

The above interlayer coating liquid was coated on the substrate so as to form a layer having a dry thickness of 2  $\mu\text{m}$ .

[0071]

<Charge generation layer (CGL)>

Y-type titanylphthalocyanine (titanylphthalocyanine having the maximum peak of Bragg's angle ( $\pm 0.2^\circ$ )  $2\theta$  of  $27.2^\circ$  in the Cu-K $\alpha$  characteristic X-ray diffraction spectrum)

20 parts

Poly(vinyl butyral) resin #6000-C (Denkikagaku Kogyo Co., Ltd.)

10 parts

t-butyl acetate 700 parts

4-methoxy-4-methyl-2-pentanone 300 parts

The above components were mixed and dispersed by a sand mill for 10 minutes to prepare a charge generation layer coating liquid. The coating liquid was coated onto the interlayer by a dipping coating method so as to form a charge generation layer having a thickness of 0.3  $\mu\text{m}$ .

[0072]

<Charge transfer layer (CTL)>

Charge transfer material: 4,4'-dimethyl-4''-

( $\alpha$ -phenylstyryl)triphenylamine 225 parts

Polycarbonate (Polycarbonate Z of the structure shown below,  
molecular weight: 30,000)

300 parts

Antioxidant: Irganox 1010 (Nihon Ciba-Geigy)

6 parts

1,3-dioxolane 2000 parts

Methyl-phenyl polysiloxane 1 part

The above components were mixed and dissolved to prepare a charge transfer layer coating liquid. The coating liquid was coated by a dipping method on the charge generation layer so as to form a charge transfer layer having a dry thickness of 20  $\mu\text{m}$ .

[0073]

<Surface layer>

Charge transfer material: 4,4'-dimethyl-4''-

( $\alpha$ -phenylstyryl)triphenylamine 225 parts

Polycarbonate (polycarbonate A composed of the following  
structural unit, molecular weight: 30,000, water absorbing  
ratio: 0.25%) 300 parts

Hydrophobic silica Table 1

Hindered amine antioxidant 6 parts

1,3-dioxoran 2000 parts

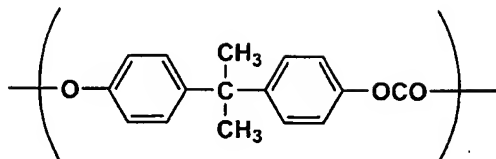
Methyl-phenyl polysiloxane 1 part

The above components were dispersed while circulating by a circulation dispersing apparatus capable of irradiating ultrasonic wave to prepare a surface layer coating liquid. The coating liquid was coated on the charge transfer layer by a circle-shaped coating amount controlling method so as to form a layer having a dry thickness of 5  $\mu\text{m}$ , and dried at 110 °C for 70 minutes to prepare Photoreceptor 1. The surface roughness Ra of thus obtained photoreceptor was 0.07  $\mu\text{m}$ . Photoreceptors listed in Table 1 were prepared in the same manner in each of which various kinds of inorganic fine particles were individually added.

[0074]

[Chem 3]

Polycarbonate A



[0075]

[Table 1]

Photo-receptor No.	Number average primary particle diameter of hydrophobic silica (nm)	Adding amount of hydrophobic silica (Parts)	Treating agent for hydrophobic silica	Hydro-phobic degree of hydro-phobic silica (%)
OPC-1	60	10	Dimethylsilicone	76
OPC-4	80	10	Methacryloxysilane	72
OPC-6	12	45	Dimethyldichlorosilane	71
OPC-3	20	10	None	0
OPC-5	120	20	Hexamethyldisilazane	72
OPC-2	5	10	Hexamethyldisilazane	75

[0076]

<Preparation example of Latex 1>

Into a 5000ml separable flask, on which a stirring device, a thermal sensor, a cooler and a nitrogen gas introducing device were attached, a solution of 7.08 g of an anionic surfactant (sodium dodecylbenzenesulfonate: SDS) dissolved in 2760 g of ion exchanged water was previously charged. The interior temperature of the flask was raised to 80 °C while stirring the solution at a stirring speed of 230 rpm under a nitrogen gas stream. On the other hand, 72.0 g of Exemplified Compound (19) was added to monomer mixture composed of 115.1 g of styrene, 42.0 g of n-butyl acrylate and 10.9 g of methacrylic acid and heated to 80 °C and dissolved to prepare a monomer solution.

[0077]

The above heated solutions were mixed and dispersed by a mechanical dispersing apparatus having a circulation pass to prepare an emulsified particles having uniform diameter. To the emulsion, a solution of 0.84 g of polymerization initiator (potassium persulfate) dissolved in 200 g of ion-exchanged water was added. Then the emulsion was heated and stirred at 80 °C for 3 hours to prepare latex particles. Thereafter, a solution of 7.73 g of the polymerization initiator dissolved in 240 ml of ion-exchanged water was added. After 15 minutes, a mixture of 383.6 g of styrene, 140.0 g of n-butyl acrylate, 36.4 g of methacrylic acid and 13.7 g of thioglycerol was dropped at 80 °C spending for 126 minutes. After finish of the dropping, the liquid was heated and stirred for 60 minutes, and then cooled to 40 °C. Thus latex particles were obtained. The latex particles were referred to as Latex 1.

[0078]

<Preparation example of Latex 2>

A latex particle was prepared in the same manner as in the latex preparation example 1 except that 15.0 g of ethyl thioglycolate and 120.0 g of Exemplified Compound (18) were each used in place of thioglycerol and Exemplified Compound (19), respectively. The product was referred to as Latex 2.

[0079]

Latexes 3 and 4 were prepared by in the same manner as in the latex preparation example 2 except that Exemplified Compounds (1) and (25) were each used in place of Exemplified Compound (18), respectively.

[0080]

[Example of preparation of toner]

<Preparation of colored particle 1>

In 160 ml of ion-exchanged water, 9.2 g of sodium n-dodecylsulfate was dissolved and stirred. To this solution, 20 g of carbon black REGAL 330R (Cabot Co., Ltd.) was gradually added and dispersed by using CLEAMIX. The particle size of the dispersion was measured by an electrophoresis light scattering

photometer ELS-800 manufactured by Otsuka Denshi Co., Ltd. The weight average particle diameter was 112 nm. This dispersion was referred to as Colorant Dispersion 1.

[0081]

Into a 5 liter four mouth flask, on which a temperature sensor, a cooler, a nitrogen gas introducing device and a stirring device were attached, 1250 g of the foregoing Latex 1, 2000 ml of ion-exchanged water and Colorant Dispersion 1 were charged and stirred. After adjusted to 30 °C, a 5 moles per liter aqueous solution of sodium hydroxide was added to adjust the pH of the mixture at 10.0. Then an aqueous solution of 52.6 g of magnesium hexahydrate dissolved in 72 ml of ion-exchanged water was added at 30 °C spending 10 minutes while stirring.

[0082]

[Table 2]

Colored particle	Latex	Temperature °C (± 0.2 °C)	Heating and stirring time (Hours)
Colored Particle 2	Latex 2	87	6
Colored Particle 3	Latex 3	83	6
Colored Particle 4	Latex 4	90	6
Colored Particle 5	Latex 3	80	5
Colored Particle 6	Latex 3	90	6

[0083]

After standing for 3 minutes, the liquid was heated and the liquid temperature was raised to 90 °C spending 6 minutes (temperature raising rate = 10 °C/minute). In such the situation, the particle diameter was measured by Coulter Counter TA-II (registered trade name), and an aqueous solution of 115 g of sodium chloride dissolved in 700 ml of ion-exchanged water was added to stop the growing of the particle when the volume average diameter was become 6.5 µm. Heating and stirring were further

continued for 6 hours at  $90\text{ }^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for desalting out and fusion-adhering the particles. Thereafter, the dispersion was cooled to  $30\text{ }^{\circ}\text{C}$  in a rate of  $6\text{ }^{\circ}\text{C}/\text{minute}$  and then hydrochloric acid was added to adjust the pH value to 2.0 and stirring was stopped. The formed colored particles were filtered and repeatedly washed by ion-exchanged water and dried by heated air at  $40\text{ }^{\circ}\text{C}$  to prepare colored particles. Thus obtained colored particle was referred to as Colored Particle 1.

[0084]

Colored Particles 2 through 5 were prepared in the same manner as in Colored Particle 1 except that Latex 2 through 4 were each used in place of Latex 1 while the temperature at which the particle growth is stopped and the heating time are varied according to Table 3.

[0085]

To each of thus obtained colored particles, 1% by weight of hydrophobic silica (number average primary particle diameter:  $12\text{ }\mu\text{m}$ , and hydrophobic degree: 68) and 1% by weight of hydrophobic titanium oxide (number average primary particle diameter:  $20\text{ }\mu\text{m}$ , hydrophobic degree: 63) were added, and the fatty acid metal salt shown in Table 3 was added and mixed by a Henschel mixer to prepare Toners 1 through 6.

[0086]

Silicone resin coated ferrite carrier having a volume average particle diameter of  $60\text{ }\mu\text{m}$  was mixed with each of thus obtained toners to prepare developers each having a toner concentration of 6%. These developers were each referred to as Developer 1 through 6 corresponding to the toners.

[0087]

[Table 3]

		OPC			Toner				Blade	Brush roller
		Inorganic particle	Hydrophobic treatment	Particle diameter $\mu\text{m}$	Surface roughness Ra	Wax		Average circular degree	Fatty acid metal salt content	
						Carboxylic acid C	Alcohol			
Example 1	OPC-1 Toner 1	Contained	Treated	60	0.07	22 Compound (19)	5	0.96	Zn-St 0.2%	Used
Example 2	OPC-1 Toner 2	Contained	Treated	60	0.07	28 Compound (18)	5	0.95	Zn-St 0.2%	Used
Example 3	OPC-1 Toner 3	Contained	Treated	60	0.07	14 Compound (1)	16	0.94	-	Used
Example 4	OPC-2 Toner 1	Contained	Treated	5	0.20	22	5	0.96	Zn-St 0.1%	Used
Example 5	OPC-3 Toner 1	Contained	None	20	0.15	22	5	0.96	Zn-St 0.1%	Used
Example 6	OPC-4 Toner 1	Contained	Treated	80	0.08	22	5	0.96	-	Used
Example 7	OPC-6 Toner 6	Contained	Treated	12	0.20	14	16	0.96	-	Used
Comparative example 1	OPC-5 Toner 2	Contained	Treated	120	0.20	28	5	0.95	-	Used
Comparative example 2	OPC-6 Toner 3	None	Treated	-	0.10	14	16	0.94	-	Used
Comparative example 3	OPC-2 Toner 4	Contained	Treated	5	0.15	12	12	0.97	-	Used
Comparative example 4	OPC-2 Toner 5	Contained	Treated	60	0.30	14	16	0.91	-	Used

[0088]

[Circular degree of toner]

The circular degree of the toner is expressed by the quotient of the circumference length of a circle having the area the same as the area of projection image of the particle divided by the length of the circumference length of the projection image of the particle, and shows irregularity of the toner shape. The circular degree is 1.000 when the toner is true sphere, and the value is lowered accompanied with rising of complexity of the surface shape. The average circular degree is an average value of the frequency distribution of the circular degree.

[0089]

[Image evaluation]

Modified one of digital copying machine SITIOS 7165, manufactured by Konica Corp., was used for image evaluation. The image evaluation machine had the processes of corona charging, laser exposure, reversal development, static image transfer, separation by claw, and cleaning by blade with cleaning assisting brush roller.

[0090]

Photoreceptors 1 through 6 were each installed and Developer 1 through 6 were each charged into the image evaluation machine for subjecting to the evaluation. The evaluation on the cleaning property and the image were carried out by copying an original image onto A4 size neutral paper. The original image was divided into four areas and on each of which an character image having a pixel ratio of 7%, a portrait photograph, a solid white image and a solid black image were arranged, respectively. At a high temperature (30°C) and a high moisture (80% RH), which were considered as the most severe conditions, 100,000 sheets of copies were continuously taken and the following evaluations were performed.

[0091]

<Evaluation of damage>

After 100,000 sheets copying, the deepness of damages formed on the surface of the photoreceptor was measured by a laser microscope. The laser microscope was LASERTECH 1LM21W (registered trade name).

[0092]

The circumference surfaces of the photoreceptor drum was examined by the microscope having an objective lens with a magnitude of 20 at the positions each far from the both end of the drum by 70 mm and the central position of the drum, and the maximum value of the damage within the visual field was subjected to the evaluation. Moreover, when a specific deep damage was visibly found, the image was subjected to the evaluation.

[0093]

×:  $R_{\max}$  was more than 2.5  $\mu\text{m}$

△:  $R_{\max}$  was not more than 2.5  $\mu\text{m}$  and less than 2.0  $\mu\text{m}$ .

○:  $R_{\max}$  was not more than 2.0  $\mu\text{m}$  and less than 1.5  $\mu\text{m}$ .

◎:  $R_{\max}$  was not more than 1.5  $\mu\text{m}$ , satisfactory level.

<Evaluation of cleaning>

The copy images of 100,000 sheets were wholly examined.

[0094]

×: Image defects caused by the passing of the toner were found in 501 or more copies, the level of the defect occurrence made problems for practical use.

△: Image defects caused by the passing of the toner were found in from 101 to 500 copies, re-examination was necessary to decide the suitability for practical use.

○: Image defects caused by the passing of the toner were found in from 31 to 100 copies, the level of the defect occurrence was made no problem for practical use.

◎: Image defects caused by the passing of the toner were found in not more than 30 copies, satisfactory level.

<Evaluation of filming>

The filming on the photoreceptor surface was evaluated by observation of the photoreceptor surface by the laser microscope,

LASERTECH 1LM21W (registered trade name) at each the finish times of continuous 50,000 copies and 100,000 copies.

[0095]

×: Considerable foreign matters were adhered after 50,000 copies or 100,000 copies.

△: No matter was adhered after 50,000 copies, but foreign matters were adhered after 100,000 copies.

○: A few foreign matters were adhered after 100,000 copies.

◎: Adhered foreign matters after 100,000 copies were little.

Results of the evaluations on the damage, cleaning and filming were listed in Table 4.

[0096]

[Table 4]

	Evaluation on damage	Evaluation on cleaning	Evaluation on filming
Example 1	◎	◎	◎
Example 2	◎	◎	◎
Example 3	◎	○	○
Example 4	◎	○	△
Example 5	○	△	△
Example 6	◎	○	○
Example 7	○	○	△
Comparative example 1	○	×	○
Comparative example 2	×	○	○
Comparative example 3	◎	△	×
Comparative example 4	◎	△	×

[0097]

#### [EFFECTS OF THE INVENTION]

The cleaning ability and the filming property of the toner with high circular degree can be improved and the image can be stably obtained for a long period by the image forming apparatus according to the invention.

#### [BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] A whole constitution of a color copying machine as an example of image forming apparatus

[Fig. 2] A cross section of the image forming portion

[Fig. 3] Drawings describing the layer structure of a photoreceptor of the invention

[EXPLANATION OF SYMBOLS]

1, 1Y, 1M, 1C, 1Bk Image carrier (Photoreceptor)

5, 5Y, 5M, 5C, 5Bk Cleaning means

10, 10Y, 10M, 10C, 10Bk Image forming unit

12, 12A, 12B, 12C, 12D, 12E, 12F Photosensitive layer

51 Brush roller

51A Supporting means

52 Elastic rubber blade

53 Supporting member



FIG. 1

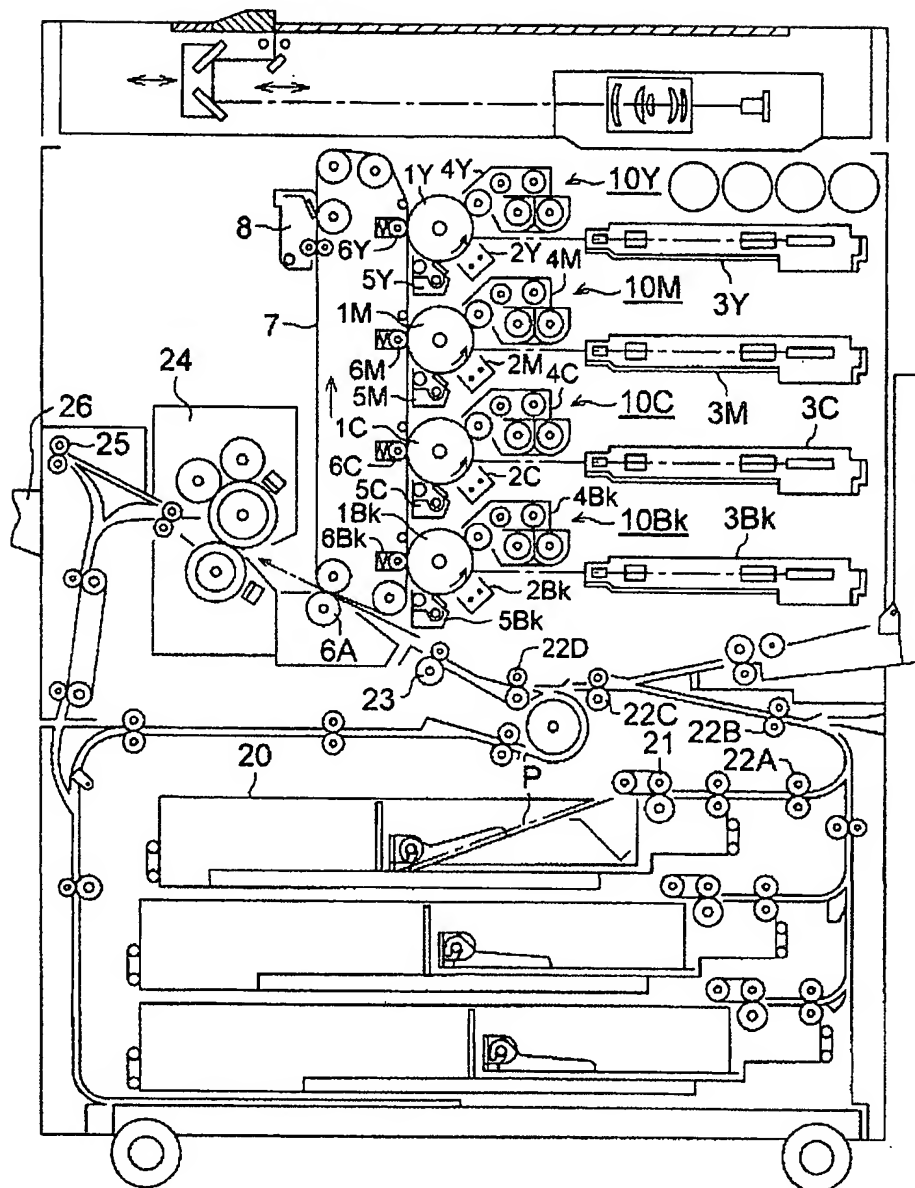


FIG. 2

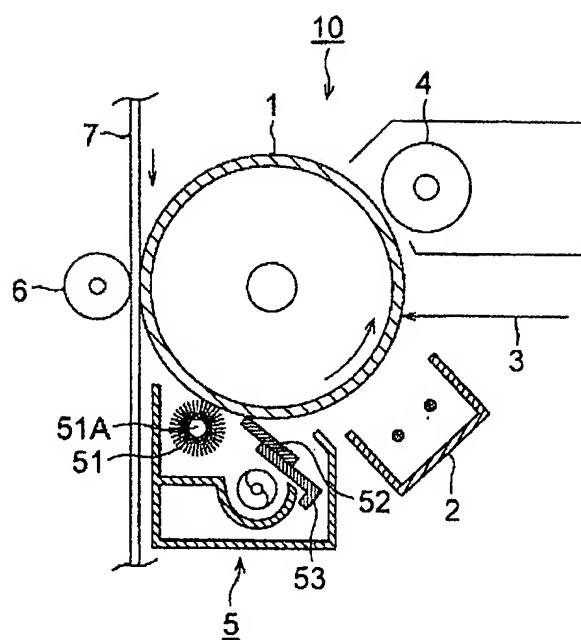


FIG. 3

